PEEM 2 User Manual

PEEM

PEEM Components

Simone Anders et al., “Photoemission electron microscope for the study of magnetic materials”, Rev. of Sci. Instrum. 70, 3973 (1999)

Double-click icon:

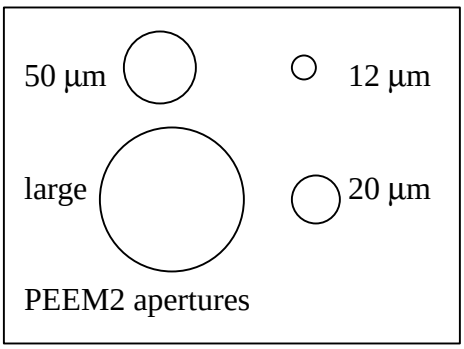
"PeemRSI Anders.pdf"

PEEM Alignment

The alignment of the PEEM electron optics is a two-step process. First the sample surface has to be aligned exactly perpendicular to the optical axis of the microscope by adjusting the four tilt screws. In a second step, the stigmator settings and the aperture position have to be optimized. Often both steps can be taken together, if the aperture is already positioned and the values for the stigmator voltages are known.

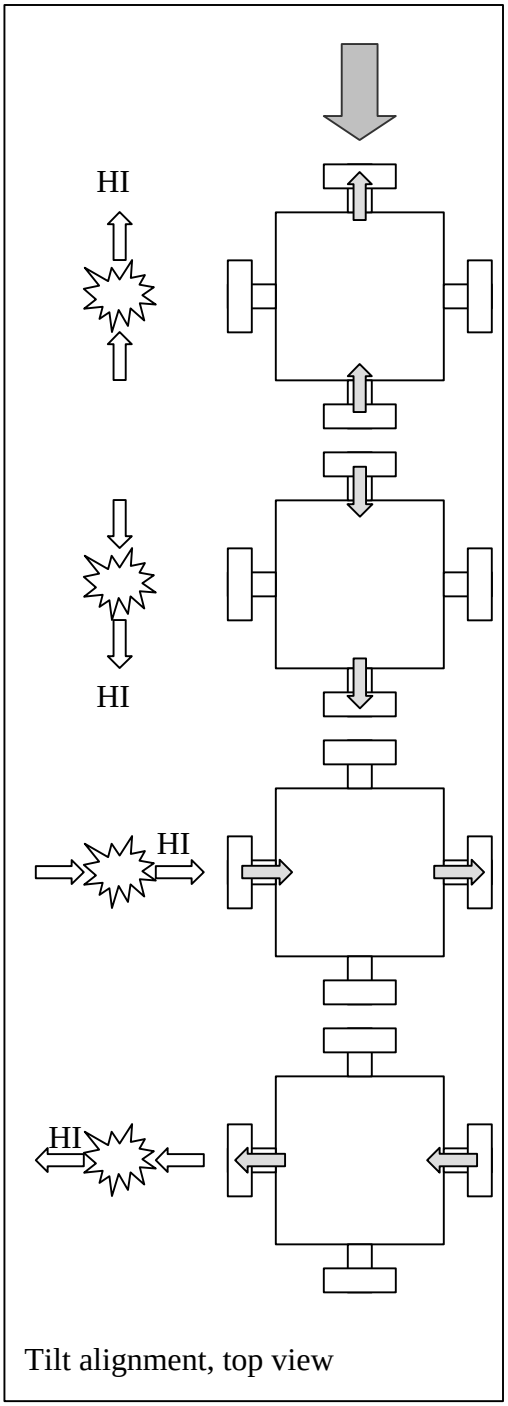
Standard alignment: (step-by-step)

1. Center sample in front of PEEM lens. Distance about 2 mm.
2. Slowly increase sample voltage to the desired value, check sample current and watch for discharges. Usually voltages between 15 kV and 20 kV can be reached, depending on sample size, morphology and conductivity. For small, rough or insulating samples the sample voltage should not exceed 15 kV.
3. Look up standard values for objective and transfer voltage. They are found in appendix XX. Run PEEM at low magnification (100 µm FOV) using the intermediate voltage. Don’t power up the projection lens. Start preview mode of the camera using ImagePro (2x2, 1s, gain 8). Adjust gain and Focus to optimize image intensity. If the image intensity is very low, step 4 has to be skipped, because the microscope is completely misaligned. If the image is pulsing or totally dark, the sample is insulating and has to be coated first with a thin (1-2 nm) metallic layer. No x-rays will hit the sample, if the sample distance differs significantly from 2 mm and the preview will stay completely dark.
4. Find structure or dust particle on the sample and adjust the sample distance until the image is focused for standard PEEM voltages. Thus the sample distance can be optimized.
5. Now move the largest aperture into the PEEM electron optics using the micrometer screws. First load the configuration file aperxxkv into the PEEM2Power, with xx standing for the desired sample voltage. The camera preview now shows an image of the aperture. Starting from the smallest aperture move down to the second smallest (about 4



turns CCW, y-direction) and then move to the left (about 4 turns CCW, x-direction)

6. To adjust the sample tilt, set the intermediate voltage to 0, use the objective voltage to focus on a dust particle and the transfer voltage to select the magnification. If necessary, move PEEM left or right to center x-ray spot under the microscope column.
7. Vary the sample voltage and watch the image movement. The sample is perfectly aligned, if the image is still. If the image moves, correct the tilt according to the pictogram to the right. For example, if the image is moving up, while increasing the objective voltage, tighten the screw opposite to the beamline and undo the screw on the beamline side.
8. Align stigmator. Stigmatism leads to an asymmetric expansion of a circular spot, when changing the objective voltage. Use stigmator slide controls on the SUN workstation to minimize stigmatism.
9. Move the smallest aperture into the PEEM electron optics using the micrometer screws. First load the configuration file aperxxkv into the PEEM2Power, with xx standing for the desired sample voltage. The camera preview now shows an image of the aperture. Move to the right to reach the second smallest aperture (about 4 turns CW, x-direction) and then move up (about 4 turns CW, y-direction) to center the smallest aperture.



Tilt alignment, top view

10. Set objective voltage to its standard value, move transfer voltage slightly below normal (about 0.1-0.2 kV) and use intermediate voltage to magnify moderately. Adjust aperture, until a bright, symmetrical, sand-glass shaped shape with a bright center appears. If necessary, move PEEM left or right to center x-ray spot under the microscope column.
11. Set transfer voltage to its normal value and increase magnification as desired
12. Continue with step 7 of the fast alignment method to further improve resolution.

Fast alignment (step-by-step)

1. Center sample in front of PEEM lens. Distance about 2 mm.
2. Slowly increase sample voltage to the desired value, check sample current and watch for discharges. Usually voltages between 15 kV and 20 kV can be reached, depending on sample size, morphology and conductivity. For small, rough or insulating samples the sample voltage should not exceed 15 kV.
3. Look up standard values for objective and transfer voltage. They are found in appendix XX. Run PEEM at low magnification (100 µm FOV) using the intermediate voltage. Don't power up the projection lens. Start preview mode of the camera using ImagePro (2x2, 1s, gain 8). Adjust gain and Focus to optimize image intensity. If the image intensity is very low, start with standard alignment, because the microscope is completely misaligned. If the image is pulsing or totally dark, the sample is insulating and has to be coated first with a thin (1-2 nm) metallic layer. No x-rays will hit the sample, if the sample distance differs significantly from 2 mm and the preview will stay completely dark.
4. Find structure or dust particle on the sample and adjust the sample distance until the image is focused for standard PEEM voltages. Thus the sample distance can be optimized.
5. Power up stigmator, using the values from the last optimization.
6. Adjust sample tilt until the image is homogeneously illuminated and the image intensity is maximized. Reduce magnification to check symmetry of illuminated area. If necessary, move PEEM left or right to center x-ray spot under the microscope column.
7. Increase magnification and search for small structure on the sample.
8. Minimize stigmatism using the stigmator controls.
9. Use the wobble mode for the objective lens to fine-tune aperture position. If the image is stationary, alignment is complete. Congratulation! If the image moves carefully adjust the aperture position and repeat step 6.

PEEM Software

Several programs on the SUN workstation (Solaris) and the PC (NT 4.0) control the beam line monochromator and the PEEM powersupplies.

PEEM programs:

Image Pro 4.0	camera software, image analysis PC, shortcut on desktop
Connect Sun	spectro-microscopy, interfaces PC – SUN PC, shortcut on desktop written in Labview
PEEM2power	PEEM powersupplies, Hotdeck powersupply SUN, /home/peemuser/peemcontrol/PEEM2power written in Labview
peem	monochromator, stigmator, SUN, /home/peemuser written in Labview

All data should be stored on the PC.
Folder for images: **D:\PeemData**\Year\Month**Images**\Filename
Filename for images: yymmdd_###.TIF. ### means the image number in consecutive order (3 digits)
Folder for spectra: D**:\PeemData**\Year\Month**Spectra**
Filename for spectra: yymmdd_subject_##.DAT (2 digits).
Local spectra are first stored on the SUN station and have to be transferred to the PC via FTP. Profile name: *PEEM2 NEXAFS* takes you to the right folder.
Other user data, have to be stored in D:\User. Users are responsible for backup of those folders. They will be deleted when storage space on D: is low. Backup of PEEM data on drive D: is done regularly on CD-ROM.

Monochromator Control with peem

The monochromator control program *peem* is located in the folder /home/peemuser on the SUN workstation. It controls the beamline monochromator and is used for spectrum acquisition in combination with the PEEM camera software ImagePro. The same software is used to control several ALS experiments (beamlines 7.3.1.1, 7.3.1.2 and 7.0). Therefore, many functions have no meaning for PEEM experiments.
Changing the first entry of the *File* menu (usually named *XANES*) to *PEEM* opens the monochromator control window for PEEM experiments. Blue boxes are input boxes. Pressing the yellow buttons repositions the monochromator. Red boxes are output boxes. They show the current position of the monochromator. Mask and chopper are located in the beamline upstream of the monochromator. They mask out part of the x-ray beam and are used to select the x-ray polarization between linear, and left and right circular. Closing the aperture defined by mask and chopper can be used to reduce the photon flux, if necessary. The photon polarization as function of chopper and mask position is shown in appendix XX. The energy calibration changes by a few eV upon change of the x-ray polarization.

Selecting the entry *Stigmator/Deflector* in the menu *Controls* opens the stigmator/deflector control window. Moving the slide controls change the stigmator and deflector voltages, if the stigmator/deflector power supply is configured *External* (switch on front panel). Usually, the PEEM deflector elements are not connected.

Troubleshooting:
Sometimes communication between SUN, PC and beamline hardware fails. Following you will find a list of countermeasures to regain control.

Close and restart the program peem on the SUN station: select the entry Quit in the menu Files in the main window. Press the Quit button in the remaining magenta colored small box. (Both programs have to be stopped!) If the programs don't react, kill them.
"**ps –a**" shows the ID numbers of all running SUN processes. You will find one or two processes: "FrontEnd" and "bl7daq". Use "**kill** ID" to stop them. Restart the program peem.

If this does not help:
Restart the beam line software on the PEEM SUN station and the µXPS SUN: Stop the programs or kill them if necessary. Start the program xpsDAQ on the µXPS SUN first. Startup of the µXPS software takes a few minutes. Then start peem on the PEEM SUN.

If this does not help or if one of the SUNs crashed and doesn't not respond to user input: Reboot the SUNs: Press keys "STOP" and "A" at the same time. Type in "reboot. Login on PEEM SUN: peemuser, password beam-er. Login on µXPS SUN: plruser, password beam-er. Initialize the VXI crates connected to the µXPS and the PEEM SUN: type *vxiinit* in a shell window, then *resman*. Restart the beamline software on both SUNs.

If this does not help: call one of the PEEM operators or Rick Steele, 7910.

If this does not help: Go to the beach or get drunk.

PEEM Control with PEEM2power

PEEM2power is located in the folder /home/peemuser/peemcontrol on the SUN workstation. It controls the PEEM electron optics. Lens values are set either by moving the horizontal slide controls or by typing in new values in the input boxes. The slide control range can be changed. If the lens power supplies are off and the program is running an error messages shows up. Start the power supplies, wait a few secs and click the OK button twice. Red lights start to blink after building up the connection successfully. After electrical discharges the power supplies may have to be switched off and on to reset them. Configuration files for different sample voltages can be loaded by selecting "LOAD Config.".Voltage sets and the corresponding magnifications/field of views can be found in appendix XX. Pressing the "XXX Off" button starts wobbling the selected lens voltage to ease PEEM alignment. Reasonable amplitudes are 0.1 –0.3 %. To manually change voltages, wobbling has to be stopped first.

Image Acquisition

A complete description of the Image Pro software can be found in the Image Pro manual. Here is a list of the important steps to acquire an image:

- set the beam line parameters (energy, mask, chopper) using the beam line program called *peem* on the SUN
- focus the image with the camera preview (reasonable Signal Options are: Integration Time: 200ms – 1s, Mode: 2x2 or 4x4, Gain: x8, Focus: 12..4 – 9..1). Focus determines which of the 12 camera bits are mapped to the 8 bits of the grayscale preview.
- snap an image (reasonable settings are: Integration Time: 1s – 90s, Mode: always Normal, Gain: usually x8 or x4, Focus: N/A)

Spectroscopy

Local spectroscopy using PEEM is realized by acquiring images at consecutive photon energies. The image intensity in one area is a measure for the local absorption coefficient. Storing all images on disk, in the following called a stack, allows calculation of local spectra in multiple locations after completion of data acquistion. Image stacks need a lot of storage space. (100 full sized images need a total of 150 MB!) Storing only an area of interest (AOI) of the full image saves disk space and speeds up spectrum calculation. An alternative method to storing the images is to measure a single spectrum in a predefined AOI without saving the image data itself. However, then calculation of additional spectra is not possible.

Procedure for spectrum acquisition in one area of interest (AOI):

- define the parameters for the spectrum in the PEEM window of the beamline software (energy ranges, mask and chopper)
- snap an image with Image Pro(reasonable settings are: Integration Time: 1s – 10s, Mode: always Normal, Gain: x8, Focus: not used), avoid overexposure on the peak, usually an average intensity of about 200-500 on the peak is sufficient for a spectrum with reasonably low noise. The selected image settings will later be used for spectrum acquisition.
- select an area of interest (square, circle or multiline) using ImagePro
- unselect the *Save Images* button in the PC-SUN communication program *Connect Sun* and push the *GO* button.
- push the “Start Scan” button in the beamline program, type in a file name and the acquisition will start. Don’t touch the Image Pro program during the measurement.
- the spectrum is stored on the SUN and has to be transferred by FTP to the PC.

Procedure for spectrum acquisition of image stacks:

- define the parameters for the spectrum in the PEEM window of the beamline software (energy ranges, mask and chopper)
- snap an image with Image Pro(reasonable settings are: Integration Time: 1s – 10s, Mode: always Normal, Gain: x8, Focus: not used), avoid overexposure on the peak, usually an average intensity of about 300-1000 on the peak is sufficient for a image

stack with reasonably low noise. The selected image settings will be used for spectrum acquisition.

- define an area of interest using ImagePro
- select whether the whole image or only the AOI (preferred) shall be stored, using the PC-SUN communication program *Connect Sun*
- selection of *Divide by* allows to divide the acquired image by a stored image, to correct for the spatially varying camera sensitivity.
  Name: d:\Camera_Correction\Noise\NoiseXXX.TIF
  XXX is the hypothetical exposure time of an image with average intensity of 2048 (gray). It is not equal to the actual exposure time, used to acquire the spectrum. It can be calculated using the following formula:
  noise_time = exposure_time * 2048 / average intensity in AOI
- selection of *Subtract* allows to subtract a stored image from the acquired image, to subtract the background intensity (dark current of CCD).
  Name: d:\Camera_Correction\Dark\DarkXXX.TIF
  Here, use the actual exposure time so select the correct dark image.
- select the TIFF Format: 8 bit, 12 bit or 16 bit. 8 bit truncates the data, only storing the most significant 8 bits. Some programs can't read 12 bit TIFFs. 16 bit TIFFs need 33% more storage space.
- type in the stack file name, which should be the same as the file name in the beam line program.
- select the *Save Images* button in the communication program Snap AOI and push the *GO* button.
- push the *Start Scan* button in the beamline program, select a file name and the acquisition will start. Don't touch the Image Pro program during the measurement.
- the spectrum is stored on the SUN and has to be transferred by FTP to the PC, the stacked images are stored on the PC in the selected folder.

Preparation Chamber

Sample Manipulator

Ion Beam Sputter Gun

Thickness Monitor

Evaporator Cells

LEED

Sample Rotation

Sample Magnetization

Sample Heating

Sample Transfer

Sample Loading

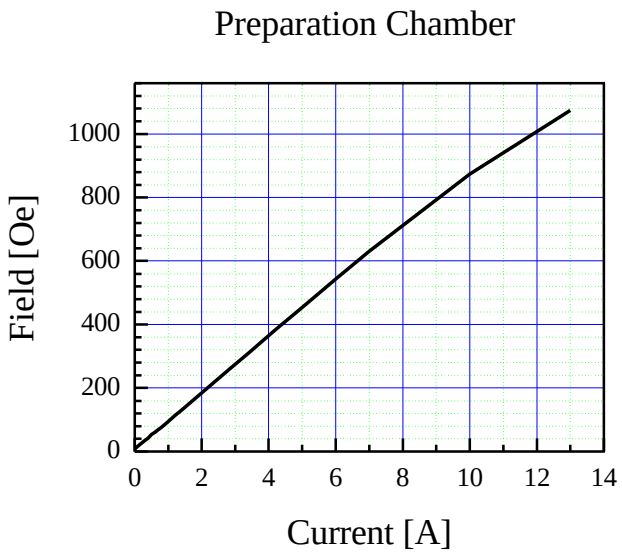
Load Lock Chamber ⇔ Preparation Chamber

Preparation Chamber ⇔ PEEM

XMCD chamber

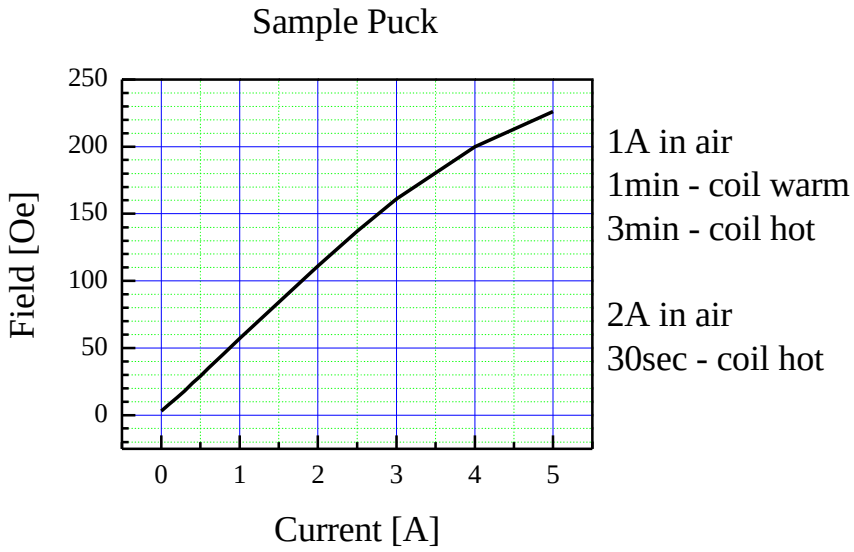
Appendices:

Magnetic Field: Coil in Preparation Chamber

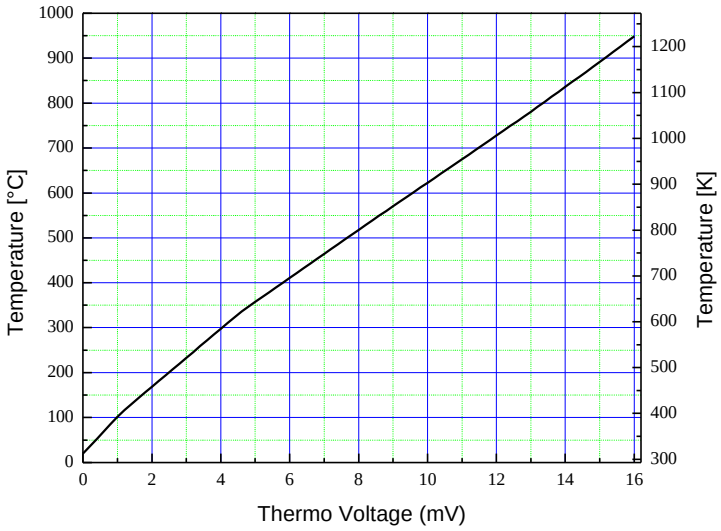


Magnetic Field: Coil in XMCD Chamber

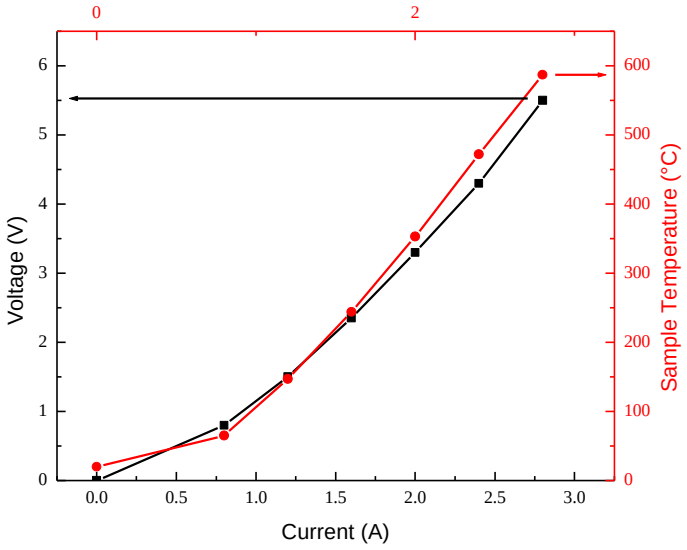
Magnetic Field: Coil on Sample Puck



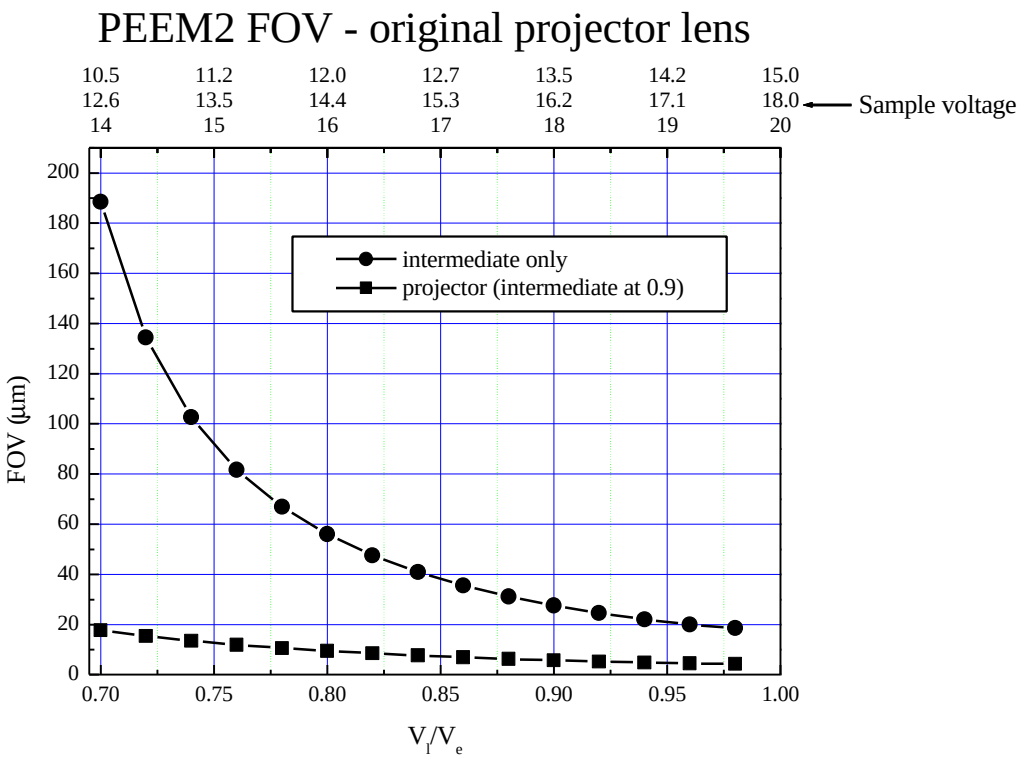
Calibration of Thermocouple

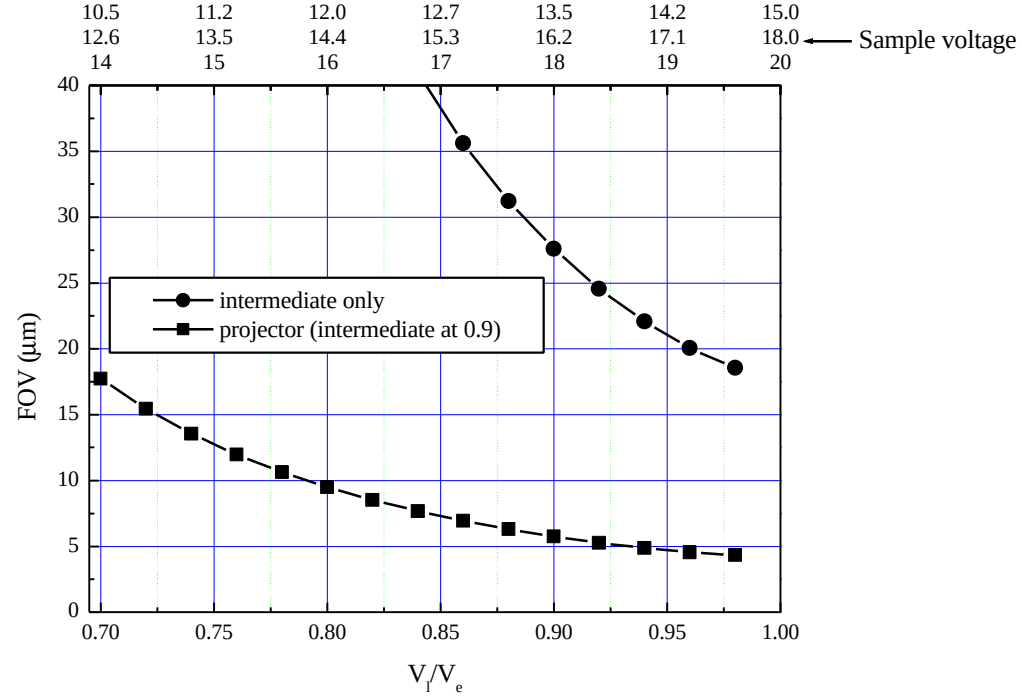


Hot Sample Puck



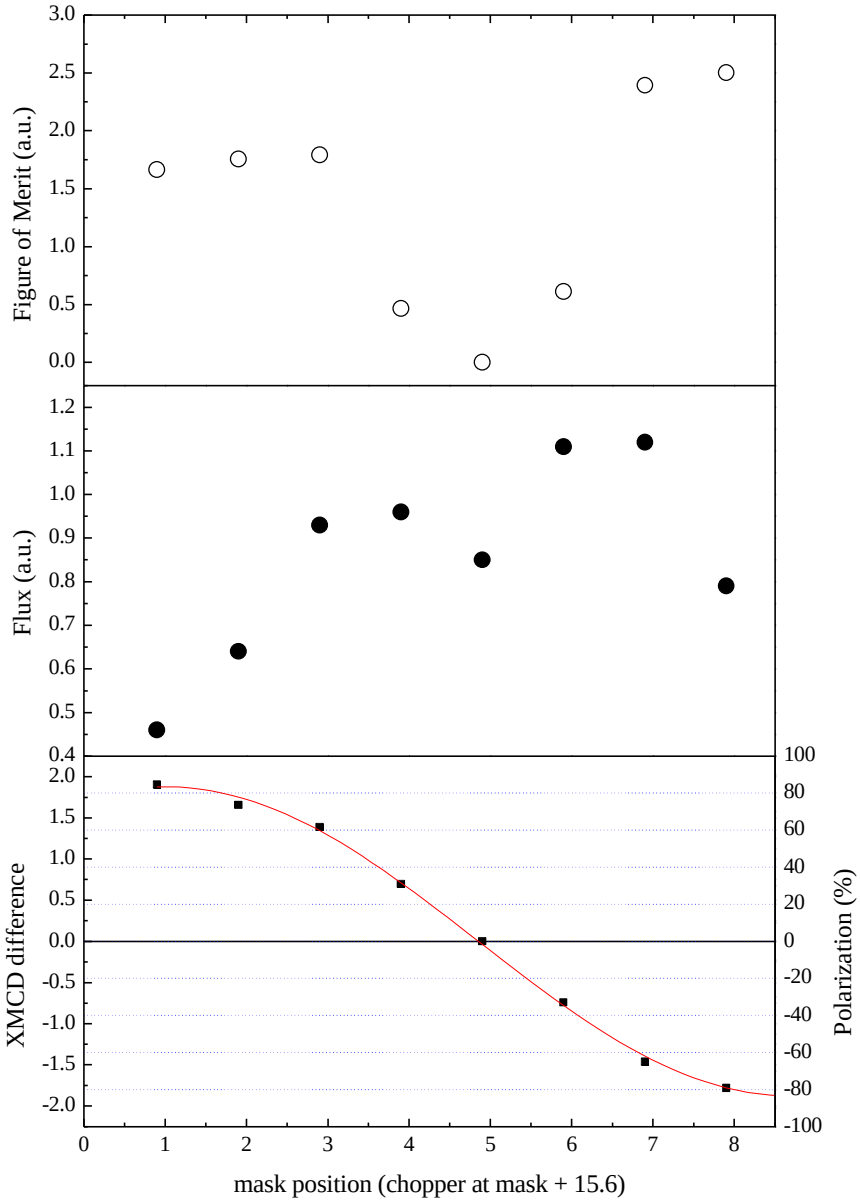
Voltage Sets for PEEM





Beamline Characteristics

beamline 7.3.1.1



Phone Numbers

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beamline 4	(510) 495-2041
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Hendrik Ohldag	(510) 486-6645
Andreas Scholl	(510) 486-4867
Jun Feng	(510) 486-2471
Home phone:	
Hendrik Ohldag	(510) 845 5417
Andreas Scholl	(510) 681-3232 (cell phone)
More numbers:	
Stanford beamline 10	(650) 926-5101
Stanford beamline 8	(650) 926-5282
Jo's lab	(650) 926-5312
Jan Lüning	(650) 926-4539
Joachim Stöhr	(650) 926-2570